With all due respect to the centennial anniversary of the Wright brothers’ first flight, the second century of powered flight really began at 1201 EDT on July 10, 2003. That’s when the FAA turned on the wide area augmentation system — WAAS for short.

Some might argue it really began about a decade earlier, with civilian access to GPS, but it is the improved lateral and vertical accuracy WAAS delivers to the satellite system’s signal that frees aviation from the limits imposed by terrestrial navaids.

In time, GPS/WAAS’s increased positional accuracy will enable more direct-to flights and increase airspace capacity through reduced separation standards. As a primary source of navigation, it will make avionics-dedicated ground-based navaids unnecessary.

WAAS’s immediate benefit is the Category 1 instrument approaches it brings to airports without the expense of building and maintaining an ILS system at each of them. All the airport needs is the appropriate runway lights. As of February 2008, the FAA had published 1,028 LPV (localizer precision with vertical guidance) approaches at 577 airports, and more are on the way (see sidebar page 49).

What makes WAAS work is a network of wide-area reference stations (WRS). They are strategically located across the nation, including in Hawaii, Alaska and Puerto Rico, ensuring coverage beyond the edges of United States airspace and into Canada and Mexico. This network sends GPS position information to a WAAS master station.

The master station compares the GPS position to each precisely surveyed WRS location, generates an “augmentation message,” and delivers it through geostationary satellites. WAAS/GPS receivers use the augmentation information to calculate an airplane’s position with reliable accuracy, delivering LPV decision altitudes of 200 to 250 feet above the runway.

Equally important, WAAS tells pilots where the GPS system is unusable because of system errors or other problems. It has six seconds to either correct the error or notify pilots they are receiving “hazardously misleading information” and should not use it for navigation. You can even check the real-time status of WAAS online at www.nstb.tc.faa.gov.

Upgrading to WAAS

To fly in the world of WAAS, aircraft must be equipped with
a receiver meeting the require-
m ents of TSO-C145a or TSO-
C146a (see sidebar page 50).
How expensive and complicated
this will be depends on what cur-
rently is in your panel.
If you have one or two of the
75,000 Garmin GNS 400/500
series units now flying, upgrading
to WAAS is a fairly simple, quick
and affordable process, depend-
ing on your airplane. If you’re
flying non-WAAS Garmin glass,
like the G1000, which is sold only
to OEMs, Garmin’s Jessica Myer
said the airframe manufacturer
handles upgrades.
If you’re not flying Garmin,
another choice is to trade in your
old boxes for new Garmin GNS
400/500W series boxes, which
are running better than $10,000
to $16,000 each, depending on
your installation.
If you decide to wait,
 Honeywell/Bendix-King
announced its new multi-func-
tion display, the KSN 770, at
EAA AirVenture 2007. It is a
big-screen (5.7-inch diagonal)
WAAS/GPS navigator and soft-
ware-based VHF and nav radio.
 Honeywell expects it to earn FAA
certification in late 2008.

Garmin Upgrade
Announced in February 2007,
the Garmin 400/500 series
WAAS upgrade program works
through the dealer network,
said Todd Adams, manager of
Lancaster Avionics, an AEA
member in Lititz, Pa. As the
portal for the work done at the
factory, dealers contacted their
customers and scheduled the
upgrades.
At first, some of Adams’ cus-
tomers wanted to trade their
legacy units for the new WAAS
GNS 430/530Ws. After compar-
ing what they got for the money,
all but one opted for the upgrade,
Adams said. Functionally,
“there’s no difference between
buying a new GNS 430/530W
and upgrading a legacy unit.”
 Garmin replaces the GPS
engine, processor and software,
and provides a new antenna, 16
MB datacard, and all the neces-
sary documentation and train-
ing materials. If the legacy unit
doesn’t already have it, Garmin
throws in the supplemental non-
certified terrain/obstacle data-
base. The upgraded GNS meets
all of the TSO-C146a specifica-
tions.
If the aircraft has two GNS
units, Adams recommends pilots
upgrade both to preserve their
cross-fill capabilities and the use
of the same database. Owners
who registered with dealers prior
to Aug. 31, 2007, paid $1,500
per unit for the factory work. After
that, the per-unit cost rose to
$2,995. The upgrade price does
not include any repairs, such as
scratched lens or sticky buttons.
Garmin charges a flat-rate repair
charge appropriate to any addi-
tional problems.
Garmin has been meeting its
projected in-house turnaround
time of three working days, and
it’s not charging for the overnight
Continued on following page…

WAAS GPS
APPROACHES

With the advent of WAAS, the
FAA has renamed GPS instrument
approach procedures to reflect the
system’s increased capabilities.

• LNAV: Lateral navigation is the
new name for a nonprecision GPS
approach. Because this approach
does not have vertical guidance, it has
a minimum descent altitude (MDA),
just like a conventional nonprecision
approach. Typically, an LNAV MDA is
400 feet above the runway.

• LNAV/VNAV: Lateral navigation/
vertical navigation approach informa-
tion is provided by an approved WAAS
GPS or a flight management system
with a VNAV-approved barometric
altimeter. With an electronic glidepath,
the approach has a decision altitude
(DA) that is usually 350 feet above the
runway.

• LPV: Localizer performance with
vertical guidance is a new approach
requiring a WAAS unit approved for it.
Much more precise than LNAV/VNAV,
LPV is the operational equivalent of
a Category I ILS approach and has a
DA between 200 to 250 feet above the
runway.
THE WORLD OF WAAS

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return, Adams said. The upgrade fee does not include the dealer’s labor and materials.

Avoiding Upgrade Surprises

Any number of things can increase upgrade time and costs, but given a chance to inspect the airplane before the upgrade, a dealer should be able to predict many of them.

If, for example, the GNS units are outside of the approved field of view, “I’ll see that you need annunciators, which are going to cost this much…” Adams said.

Before pulling the boxes, Lancaster Avionics starts the WAAS upgrade by documenting every setting on the unit’s installation and calibration pages, which only the shop can access. This has many benefits. Most importantly, it helps the shop confirm the components that interface with the Garmin comply with the upgrade’s supplemental type certificate. Any interface that does not comply will require additional work and an FAA field approval, according to Adams, giving several common examples.

Aircraft with the Sandel SN3308 electronic HSI require some rework to depict GPS vertical deviation and the required annunciation, with the exception of INTEG. Aircraft with an S-TEC ST-901 steering adapter likely will need a relay or additional wire between the GNS and the ST-901 converter.

The upgraded GNS will not talk to the Garmin GDL 49 datalink system. Owners who want this capability will need the new GDL 69 system, which delivers XM WX Satellite Weather and XM Satellite Radio.

In short, every upgrade is unique, Adams said, and the only way a dealer can predict the time and cost is to examine the installation.

Efficiently configuring upgraded WAAS units is a second benefit of the pre-upgrade documentation. When Garmin returns the upgraded GNS, “it’s like a brand-new unit, all of the [previous] settings are wiped out,” Adams said. This includes user-defined settings, and Adams recommends pilots document them before the upgrade. If they have special-use operations, stored flight plans for a pipeline patrol, CAP or Coast Guard operations, “pilots should write them down so they can reload them afterward.”

Pilots also can see for themselves if their GNS units are in the “acceptable viewing area.” (However, the shop makes the final determination.) In other words, the pilot can see the needed annunciations on the screen without excessive head movement, never a good thing when flying an instrument approach to minimums.

Assuming a standard installation, the GNS 430/530 is to the pilot’s right and on the same vertical plane as the six-pack instruments. (Units below this plane, as in the Cirrus SR series, are outside of the acceptable area.) To be in the acceptable area, the unit’s left bezel edge must be no more than 11.8 inches from the center of the pilot’s scan, a line that typically bisects the attitude indicator.

If the bezel is more than 11.8 inches, but less than 13.41 inches, the upgrade needs a VLOC/GPS annunciator. If it is beyond 13.41 inches, it needs all of them: VLOC/GPS, MSG, WPT, APR, TERM and INTEG.

An option is to install an appropriate EHSI or primary flight display that will display the GPS annunciations.

Included in the factory price is a new antenna. It has the same footprint as the old one, but it requires a new TNC connector and a specific length of a higher-grade coax. GPS is sensitive to radio frequency interference, and WAAS is even more so, according to Adams.

Black RG58 coax does not provide the necessary shielding; WAAS’s minimum requirement is orange-tan colored RG400 or RG142B/U.


For WAAS, the equipment must meet the requirements of TSO-C145a, “Airborne Navigation Sensors Using the GPS Augmented by the Wide Area Augmentation System,” or, to qualify as the primary source of navigation, TSO-C146a, “Stand-Alone Airborne Navigation Equipment Using the GPS Augmented by the Wide Area Augmentation System.”

Most general aviation WAAS receivers comply with TSO-C146a, which applies to panel-mounted navigation equipment (as opposed to sensors providing data to a flight management system).
To provide proper attenuation, the cable must run between 6.5 feet and 35 feet long. Adding cable corrects a shortage, but if there is no way to shorten the run, Adams said going to an even higher grade of coax with the N-number, make and model to the dealer performing the upgrade. Projected downtime is 10 working days for the PFD, not counting shipping; dealers can upgrade the MFD in the field.

To fly in the world of WAAS, aircraft must be equipped with a receiver meeting the requirements of TSO-C145a or TSO-C146a. How expensive and complicated this will be depends on what currently is in your panel.

To fly in the world of WAAS, aircraft must be equipped with a receiver meeting the requirements of TSO-C145a or TSO-C146a. How expensive and complicated this will be depends on what currently is in your panel.

Cirrus Challenges

When upgrading a Cirrus SR series airplane with Avidyne glass, owners not only will need to upgrade the Garmin 430s, but also they will need Avidyne Release 7 software and two Cirrus antenna kits, which take the place of the Garmin units.

Obviously, a Cirrus with steam gauges doesn’t need the new software, but it will need annunciators because the GNS units are below the acceptable viewing area.

Avidyne Release 7 delivers WAAS to the primary flight display and multi-function display without any wiring changes. If the owner is running Release 6.0 or better and the unit is under warranty, the upgrade is $2,395, plus shipping, labor and applicable tax. Beyond warranty, it is $3,895. (All other aircraft are eligible for the Avidyne WAAS upgrade contingent on the airframe manufacturer’s requirements.)

To order the upgrade, owners must register their PFD/MFD at www.myavidyne.com and provide the serial numbers of the PFD, MFD and aircraft, along

The Garmin upgrade is the same, except Cirrus owners save $440 on each Garmin antenna. Instead, they must purchase the Cirrus antenna kit appropriate for their aircraft and accompanying service bulletin. The kit for the No. 1 GPS is $1,878 if XM weather is installed, and $1,240 without XM. The kit for the No. 2 GPS is $1,226 or $1,141, depending on the compliance with another mod.

Final Steps

After reinstalling the upgraded GNS units, the dealer configures them according to their pre-upgrade documentation, making any changes as necessary. Then comes the great unknown: the final check of the Garmin box and everything that interfaces with it.

Radio frequency interference (RFI) is the greatest unknown, Adams said, reiterating WAAS is even more sensitive to it than a straight GPS.

“Even though it passed the test before doesn’t mean it’s going to pass the test now,” he said. “If there’s a problem, then we have to jump through all kinds of hoops until it’s resolved. So, until that’s done, you don’t

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Universal Avionics Adds to WAAS Family

Universal Avionics Systems Corp. offers a WAAS flight management system with the ability to fly LPV, LNAV/VNAV and LNAV-only approaches. Universal’s WAAS-FMS family includes the UNS-1Ew, UNS-1Espw, UNS-1Fw and UNS-1Lw.

These WAAS-enabled systems contain a precise, augmented GPS receiver capable of navigating approaches to ILS minimums.

According to Universal Avionics, its WAAS-enabled super flight management systems are designed to be compatible with the systems being implemented in Europe (EGNOS), Japan (MSAS) and other future systems compliant with the standards established in RTCA CO-229, in addition to the support for WAAS in the United States.

Universal Avionics recently announced its new LP/LPV monitor, which provides specialized monitoring and position information for RNAV (GPS) LP/LPV approaches. Together, the LP/LPV monitor and the Universal WAAS-FMS make it possible to obtain operational approval for WAAS LPV approaches in a single Universal Avionics WAAS-FMS installation. The monitor will be certified to TSO-C146b, Class Gamma-3 and is expected to be available later in 2008.
Garmin GNS 430/530W. The good news is, any airframe and powerplant technician can perform the four-step inspection:

- Make sure the box is secure in the rack.
- Make sure all the faceplate legends are legible.
- Make sure none of the wiring is chaffing.
- Make a logbook entry stating the system was examined in accordance with the Instructions for Continued Airworthiness.

Without this examination, pilots cannot use their upgraded units for VFR or IFR navigation or communications, Adams said.

“I’ve been telling pilots to call the mechanic who does their annual inspection immediately and have them add this inspection to the airplane’s list of things to do,” he said.

In so doing, the aircraft will be legally welcome in the great world of WAAS.